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Local Recreational Parks as Hospitable Habitats for Small Aquatic Animals: Examples of Copepod Crustaceans in Virginia

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ABSTRACT

Copepod microcrustaceans were collected from wetlands in five county parks and one privately managed neighborhood park in the Piedmont region of Virginia. A total of 43 species was found, 9 to 19 copepod species in each park. First state records were established for 16 species: *Acanthocyclops brevispinosus, A. exilis, A. parasensitivus, A. robustus, Ectocyclops phaleratus, Eucyclops conrowae, Itocyclops yezoensis, Megacyclops latipes, Microcyclops varicans, Orthocyclops modestus, Paracyclops chiltoni, Bryocamptus newyorkensis, B. nivalis, Canthocamptus assimilis, C. sinuus*, and *Phyllognathopus viguieri*. Some of the species are very rarely collected, and eight are new to science. This surprising degree of diversity suggests that local parks provide important habitats for small-sized aquatic fauna.

Key words: Copepoda, Crustacea, new records, parks, Virginia.

INTRODUCTION

Naturalists often seek to collect the plants and animals of interest in the most pristine possible habitats, i.e., large preserves such as national and state parks and national forests. However, organisms which require only small spaces and are relatively adaptable to disturbance may successfully maintain populations in fragments of limited area, such as are often found in local recreational parks. I report on copepod crustaceans collected from wetlands in five county parks and one neighborhood park in the Piedmont region of Virginia.

Copepods occur in almost every kind of wetland. Although they are best known as a significant part of the plankton of lakes, reservoirs, large rivers, and the oceans, by far the majority of copepod species live in the benthos, and in marshes and bogs, seeps, springs, damp moss, wet soils, sandy streambeds, caves, and groundwater. The faunas of non-planktonic habitats of most continents except Europe are relatively little known. The collections reported here were made as part of an ongoing survey of the copepod crustaceans living in the full range of freshwater habitats in the Commonwealth of Virginia.

STUDY AREAS

Four of the parks are located in Henry County in the southwest Piedmont. One, Vint Hill Farms Park, is located near Warrenton in Fauquier County, in the central Piedmont. DeJarnette Park lies within the town limits of Ashland in Hanover County, on the eastern edge of the Piedmont near the Coastal Plain (Fig. 1).

The types of wetland habitats differ among the parks:

Doe Run Park, maintained by Henry County, is 30 acres (12 ha) in area, most of which is hilly and covered with older second-growth hardwood trees. Where it crosses the park, Doe Run, a small, first-order stream, has a relatively wide floodplain containing several ephemeral sloughs. East of the stream is a shallow, permanent, artificial pond, wooded around most of its perimeter. The pond drains into the creek through a permanently wet, grassy slough.

Fisher Farm Park is also maintained by Henry County. Although mostly given over to playing fields, the park borders Marrowbone Creek, a third-order stream. The creek at this point is dammed, forming a small impoundment, and along the edges of the impoundment are a few small sloughs. Down the steep, wooded creek bank runs a tiny, unnamed, apparently perennial seep stream.

The third park in Henry County is Jordan Creek Park in Fieldale. Like Fisher Farm Park, it is mostly used for playing fields. The park is bordered by Jordan Creek, a third-order stream with a narrow strip of brush and hardwood trees along its banks. The creek has a number of bars of coarse sand and gravel, and its 2-4 foot (0.6-1.3 m) high banks are lined with rocks, moss, and muddy soil. In an open field near the parking lot is a shallow slough that contains at least some water most of the year; the vegetation is grass with a few sedges.

Lake Lanier in Martinsville is a private park maintained by the Lake Lanier Association. The aquatic habitats in the park consist of the lake itself, and moist soils, moss, and drifts of decaying leaves along its shoreline. Above the shoreline are shallow, ephemeral puddles and a few tiny ephemeral seeps on steeper parts of the shore. Part of the shore is wooded, but most is open lawn or gravel paths. The lake is fed by Mulberry Creek, but nearly all of the creek lies outside the Lake Lanier park area, and I did not collect in the creek itself.

Vint Hill Farms Park is about 10 acres (3.5 ha) in extent, and consists of open grassy fields bordered by South Branch, a small creek 3 to 4 m wide, with a sandy and gravelly bottom and a strip of small second-growth hardwood trees along both banks. The aquatic habitats include South Branch itself, small sloughs and seeps in its floodplain, and grassy drainage ditches. At the time of the visit, the ditches contained standing water. The collections were made from the ditches and from standing or slowly flowing water in the muddy path leading to the creek, and in an adjacent shallow slough filled with water and decaying leaves.

DeJarnette Park covers an 8-acre (3.2 ha) tract and includes Stony Run along its border; part of this creek is diverted to form a small pond. South of the pond, a tiny unnamed seep runs slowly through an acid bog developed in an open stand of mixed pines and hardwoods.

Doe Run, Jordan Creek, and Lake Lanier each were visited several times from 2001 through 2006. Fisher Farm, Vint Hill Farms, and DeJarnette parks were each visited once. The dates of the visits are given in a footnote to Table 1.

COLLECTING STRATEGY AND METHODS

The collecting effort and strategy varied somewhat with each visit. On the first (or only) visit, I collected one or more samples of plankton and bottom sediments from each body of open water, with a small plankton net, or with a modified scoop net fitted with a screen cover to avoid clogging with leaves. In any wet areas without open water, I collected samples of sediment such as decaying leaves or grass, mud, sand, or moss. In streams, I dug one or more shallow holes in sand- and gravel-banks, and filtered the water infiltrating into the holes through a small plankton net. On subsequent visits, I took repeat samples in habitats which had been especially productive of species, and also sampled from any wet areas which had not held water during previous visits. All samples were placed in plastic bags and transported to the laboratory.

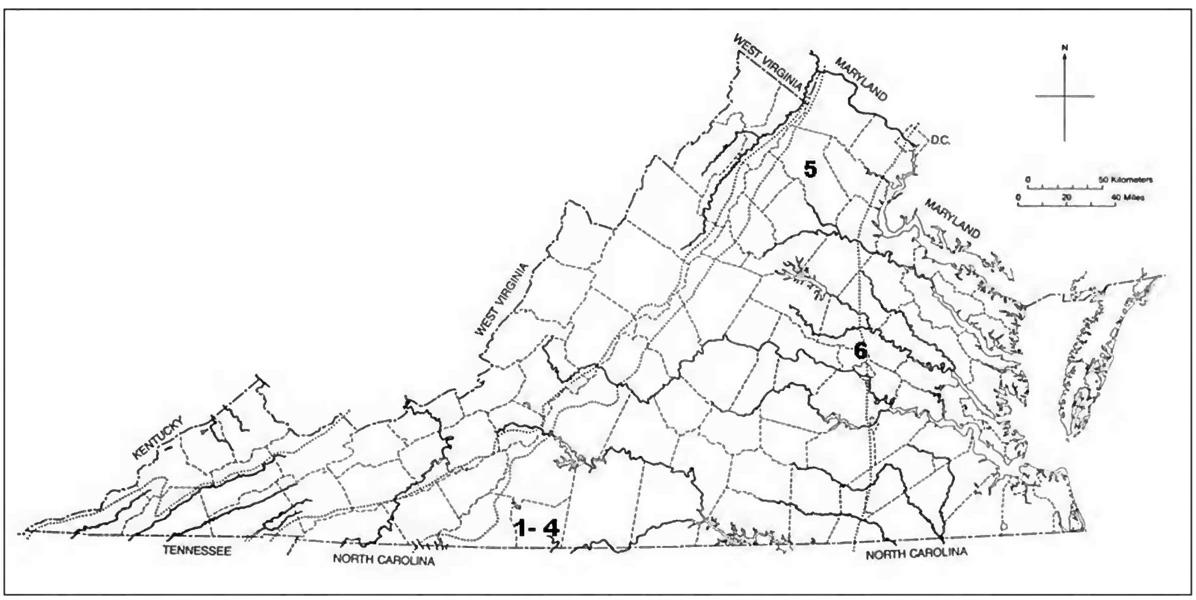

Fig. 1. Locations of parks sampled for copepods during this study. 1, Doe Run. 2, Fisher Farm. 3, Jordan Creek. 4, Lake Lanier. 5, Vint Hill. 6, DeJarnette.

To separate the copepods, I added water to the sediments, agitated them, and decanted the water through a hand net with an 80 µm mesh. I then inverted the net and rinsed the contents into a glass Petri dish. Using a Wild dissecting microscope and 15 to 50 X magnification with substage illumination, I then examined subsamples poured into successive Petri dishes for copepods, which can easily be seen swimming in the dishes. Addition of a small amount of 70% ethanol to anesthetize the animals facilitated capture of the faster swimmers. I picked out the copepods with a fine pipette, and fixed and stored them in 70% ethanol.

Voucher specimens of all the species are deposited in the Recent Invertebrates Collection of the Virginia Museum of Natural History.

RESULTS

A total of 43 copepod taxa occurred in the samples (Table 1). The number of taxa found in each individual park ranged from 9 to 19. Only one species of calanoid was collected. The remainder of the collection was about equally divided between cyclopoids (22 species) and harpacticoids (20 species and subspecies).

The composition of the collections varied according to the array of available habitats, and apparently with the particular nature of each. For example, the array of species found in the open water of each of the four impoundments was quite different. Only Lake Lanier contained a planktonic calanoid, *Skistodiaptomus pallidus*; and also the planktonic cyclopoids *Acanthocyclops brevispinosus* and *Tropocyclops prasinus mexicanus*, and (primarily in nearshore sediments) the typically epibenthic cyclopoids *Eucyclops agilis, Eucyclops conrowae, Eucyclops elegans, Macrocyclops albidus, Paracyclops chiltoni*, *P. poppei*, and the harpacticoid *Elaphoidella bidens*. The tiny Marrowbone Creek impoundment contained numerous *A. brevispinosus* and *T. prasinus mexicanus*, and the epibenthic *E. agilis*, *M. albidus*, and *P. poppei*. Of planktonic species, the shallow pond in Doe Run Park contained only *T. prasinus mexicanus*, and was otherwise populated with the epibenthic *Ectocyclops phaleratus, E. agilis, E. elegans, M. albidus, Microcyclops varicans*, and *E. bidens*. The pond in DeJarnette Park was thick with a filamentous blue-green alga, from which I was able to separate only a few specimens of *Diacyclops thomasi* (a planktonic species) and *E. agilis*.

The number of species also varied according to the number of visits, i.e., the collecting effort (Fig. 2). The most intense collecting effort was expended in Doe Run Park and Lake Lanier: six visits to each, at all seasons of the year. Jordan Creek was visited three times. It is clear from the cumulative number of species found that even in an area with few available subhabitats such as Jordan Creek, more than three visits are necessary to find all of the copepod species.

DISCUSSION

The total of 43 species found is impressive, considering that the published records of free-living (nonparasitic) copepods from fresh waters within the state include a total of 66 species (18 calanoids, 26 cyclopoids, and 22 harpacticoids).

As would be expected, most of the species previously recorded from the state and found in these parks are common and widespread throughout North America. The planktonic calanoid *Skistodiaptomus pallidus* is common in impoundments throughout Virginia (Saunders, 1975; J. W. Reid, unpublished data). *Acanthocyclops vernalis* has been reported from a wide range of habitats, but because the taxonomy and biological relationships of the morphologically variable members of the *vernalis-robustus* group are incompletely understood, records of *A. vernalis* may refer to any of several named and unnamed morphs. The problem was discussed most recently by Dodson et al. (2003) and Mirabdullayev & Defaye (2004). *Diacyclops thomasi, Eucyclops agilis, E. elegans, Macrocyclops albidus*, and *Tropocyclops prasinus mexicanus* are all characteristic of impoundments. In Virginia, *Paracyclops poppei, Attheyella nordenskioldii, Bryocamptus zschokkei*, and *B. zschokkei alleganiensis* are common primarily among decaying leaves in small streams and seeps; *A. americana* in acid bogs; *A. illinoisensis* in bogs and sloughs; *Elaphoidella bidens* in organically rich streams and sloughs; *Epactophanes richardi* in sandy streambeds and banks; *Moraria cristata* in tiny seepage streams and associated wet moss; and *Moraria virginiana* in springs, seeps, bogs, and wet moss.

Sixteen of the species are previously known to science and are now reported for the first time from Virginia. These are *Acanthocyclops brevispinosus, A. exilis, A. parasensitivus, A. robustus, Ectocyclops phaleratus, Eucyclops conrowae, Itocyclops yezoensis, Megacyclops latipes, Microcyclops varicans, Orthocyclops modestus, Paracyclops chiltoni, Bryocamptus newyorkensis, B. nivalis, Canthocamptus assimilis, C. sinuus*, and *Phyllognathopus viguieri*. Again, several of these are widespread, although not all of them are common or abundant, in the appropriate habitats: *A. brevispinosus* in eutrophic impoundments, *A. exilis* in springs and small streams, *A. robustus* in vernal pools, *E. phaleratus* and *E. conrowae* in the

Table 1. Species of copepods found in six small parks in the Virginia Piedmont.

Species	Doe Run[a]	Fisher Farm[b]	Jordan Creek[c]	Lake Lanier[d]	Vint Hill Farms[e]	DeJarnette[f]
Order Calanoida						
Skistodiaptomus pallidus (Herrick, 1879)				X		
Order Cyclopoida						
Acanthocyclops brevispinosus (Herrick, 1894)		X		X		
Acanthocyclops exilis Coker, 1934					X	
Acanthocyclops parasensitivus Reid, 1998						X
Acanthocyclops robustus (G.O. Sars, 1863)	X				X	
Acanthocyclops vernalis (Fischer, 1853)	X					
Acanthocyclops sp.			X			
Diacyclops crassicaudis brachycercus Kiefer, 1927	X			X	X	
Diacyclops sp.	X	X	X			
Diacyclops thomasi (S.A. Forbes, 1882)						X
Ectocyclops phaleratus (Koch, 1838)	X					
Eucyclops agilis (Koch, 1838)	X	X		X	X	X
Eucyclops conrowae Reid, 1992	X			X		
Eucyclops elegans (Herrick, 1884)	X		X	X		
Eucyclops sp.			X			
Itocyclops yezoensis (Ito, 1953)			X			
Macrocyclops albidus (Jurine, 1820)	X	X	X	X	X	
Megacyclops latipes (Lowndes, 1927)		X				
Microcyclops varicans (G.O. Sars, 1862)	X		X	X		
Orthocyclops modestus (Herrick, 1883)	X					
Paracyclops chiltoni (Thomson, 1882)				X		
Paracyclops poppei (Rehberg, 1880)	X	X		X		X
Tropocyclops prasinus mexicanus Kiefer, 1938	X			X		
Order Harpacticoida						
Attheyella americana (Herrick, 1884)						X
Attheyella illinoisensis (S.A. Forbes, 1882)	X	X	X	X		
Attheyella nordenskioldii (Lilljeborg, 1902)					X	
Bryocamptus hiatus (Willey, 1925)						X
Bryocamptus newyorkensis (Chappuis, 1927)				X		X
Bryocamptus nivalis (Willey, 1925)		X				
Bryocamptus zschokkei zschokkei (Schmeil, 1893)		X				
Bryocamptus zschokkei alleganiensis Coker, 1934			X			
Bryocamptus sp.		X	X			
Canthocamptus assimilis Kiefer, 1931						X
Canthocamptus sinuus Coker, 1934	X		X			
Elaphoidella bidens (Schmeil, 1893)	X		X	X	X	
Elaphoidella sp. A				X	X	
Elaphoidella sp. B			X			
Epactophanes richardi Mrázek, 1893	X	X		X		
Moraria cristata Chappuis, 1929		X	X			
Moraria virginiana Carter, 1944		X				X
Parastenocaris sp. A					X	
Parastenocaris sp. B	X					
Phyllognathopus viguieri (Maupas, 1892)	X	X	X			
Total	19	14	15	16	9	9

[a] Visited on 21 June, 8 and 20 September, and 25 November 2003, 11 July 2004, and 7 January 2006.
[b] Visited on 29 June 2003.
[c] Visited on 13 August and 21 September 2003, and 2 March 2006.
[d] Visited on 8 and 10 January and 19 August 2002, 5 September and 2 November 2003, and 9 April 2006.
[e] Visited on 28 November 2004.
[f] Visited on 20 February 2006.

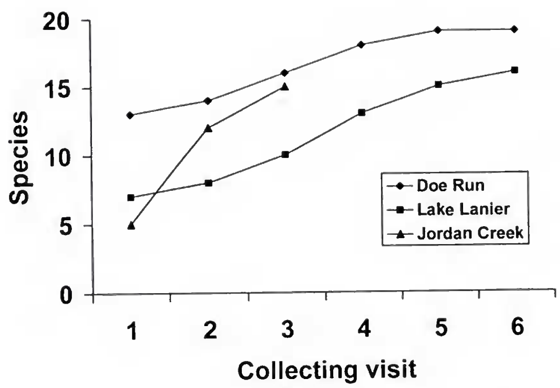

Fig. 2. Species accumulation curves for copepods collected in Doe Run, Lake Lanier, and Jordan Creek parks.

bottom sediments and decaying leaves in small ponds, *M. latipes* in small streams and pools, and sometimes in caves, *M. varicans* in sloughs and small ponds, *O. modestus* in ephemeral sloughs, *P. chiltoni* and *B. nivalis* in springs and seeps, *C. assimilis* and *C. sinuus* in permanent and ephemeral standing waters from large impoundments to shallow sloughs, and bog pools; and *P. viguieri* in seeps, bogs, and damp leaf litter and moss.

Several of the new records are particularly valuable. The find of *Bryocamptus hiatus* is only the second record for the state; the species was previously reported from streams in Surry County by Gladden & Smock (1990). *Bryocamptus newyorkensis* is another widespread but rarely collected species. It has not previously been reported from Virginia, although it ranges at least from New York to Florida (Bruno et al., 2002).

Acanthocyclops parasensitivus was described from bogs in Anne Arundel and Wicomico counties, Maryland; and a sandbar in a creek in Pulaski County, Kentucky (Reid, 1998). Additional, recent records from Tennessee and Indiana (J. W. Reid and J. L. Lewis, unpublished data) and from a creek in Hanging Rock State Park in North Carolina (collected by J. W. Reid on 4 March 2006; specimens deposited in the VMNH) indicate that *A. parasensitivus* is widespread in the eastern U.S.A., although rarely collected. The new find in DeJarnette Park places it in another major river system, the James, draining into the Chesapeake Bay.

The most unexpected new record is that of *Itocyclops yezoensis*. This tiny cyclopoid is known from small, permanent or ephemeral springs, seeps, and streams. It has a strikingly disjunct distribution in Japan, Korea, Alaska, and one location in the Great Smoky Mountains, Tennessee (Reid & Ishida, 2000; Lee et al., 2004). Because the location where the Tennessee find was made is in a spring near a former vacation home where exotic ornamental plants had been grown, it might have been argued that the Tennessee population was artificially introduced. The new find in Virginia, from moist soil on the bank of Jordan Creek, indicates that *I. yezoensis* is a natural component of the cyclopoid fauna of the southeastern U.S.A., although an extremely rare one. In regard to the question of whether these widely disjunct populations might represent sibling species, Reid & Ishida (2000) were unable to find consistent morphological differences between females from Japan, Alaska, and Tennessee. The major chetotaxy (numbers of spines and setae) of females of the Jordan Creek population falls within the range of variation reported by Reid & Ishida (2000). None of these populations has yet been compared genetically.

The high proportion (8 of 43, 18%) of previously undescribed taxa is also striking, and illustrates the degree of our ignorance of the copepod fauna of non-planktonic habitats in North America. Forró et al. (2003), working in Belgium, which has an extremely dense human population and is one of the most environmentally altered countries in the world, discussed the importance of small surface waterbodies in providing habitats for microcrustaceans, many of which are ecological specialists that are adapted to just these kinds of inconspicuous and often ephemeral habitats.

The new taxa will be described elsewhere. The finds of new species, together with the several valuable new records and numerous additions to the faunal list for Virginia, emphasize the importance of these small, local parks in protecting and conserving cryptic aquatic animals.

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LITERATURE CITED

Boxshall, G. A., & S. H. Halsey. 2004. An Introduction to Copepod Diversity. 2 Volumes. The Ray Society, London. 966 pp.

Bruno, M. C., J. W. Reid, & S. A. Perry. 2002. New records of harpacticoid copepods from Everglades National Park (Florida, U.S.A.): Description of *Nitokra evergladensis*, new species (Ameiridae), supplementary description of *Attheyella americana*, and redescription of *Bryocamptus newyorkensis* (Canthocamptidae). Journal of Crustacean Biology 22: 834-854.

Dodson, S. I., A. K. Grishanin, K. Gross, & G. A. Wyngaard. 2003. Morphological analysis of some cryptic species in the *Acanthocyclops vernalis* species complex from North America. Hydrobiologia 500: 131-143.

Forró, L., L. De Meester, K. Cottenie, & H. J. Dumont. 2003. An update on the inland cladoceran and copepod fauna of Belgium, with a note on the importance of temporary waters. Belgian Journal of Zoology 133: 31-36.

Gladden, J. E., & L. A. Smock. 1990. Macroinvertebrate distribution and production on the floodplains of two lowland headwater streams. Freshwater Biology 24: 533-545.

Lee, J. M., J. M. Jeon, & C. Y. Chang. 2004. Two semi-subterranean copepods from Korea. Korean Journal of Biological Sciences 8: 145-154.

Mirabdullayev, I.M., & D. Defaye. 2004. On the taxonomy of the *Acanthocyclops robustus* species complex (Copepoda, Cyclopidae): *Acanthocyclops brevispinosus* and *A. einslei* sp. n. Vestnik Zoologii 38: 27-37.

Reid, J. W., & T. Ishida. 2000. *Itocyclops*, a new genus proposed for *Speocyclops yezoensis* (Copepoda: Cyclopoida: Cyclopidae). Journal of Crustacean Biology 20: 589-596.

Saunders, J. F., III. 1975. The occurrence of *Diaptomus (Skistodiaptomus) pallidus* Herrick and *D. (S.) pygmaeus* Pearse (Copepoda: Calanoida) in Virginia. Virginia Journal of Science 26: 126-127.